

CLAIMS:

1. A hydraulic control apparatus for a hydraulic servo unit that selectively changes an operation direction between a first direction when an oil is supplied from a first port and discharged from a second port and a second direction opposite to the first direction when the oil is supplied from the second port and discharged from the first port, the hydraulic control apparatus characterized by comprising:

a first oil flow control valve and a second oil flow control valve each having an oil supply control portion that controls an oil supply from a pressurized oil source, and an oil discharge control portion that controls a connection with an oil discharge passage; and

control valve operation control means that controls each operation of the first and the second oil flow control valves,

wherein the first port receives an oil supply from the oil supply control portion of the first oil flow control valve, and discharges the oil through the oil discharge control portion of the second oil flow control valve,

wherein the second port receives the oil supply from the oil supply control portion of the second oil flow control valve, and discharges the oil through the oil discharge control portion of the first oil flow control valve, and

wherein an operation state of the hydraulic servo unit is controlled by the control valve operation control means that controls each operation of the first and the second oil flow control valves.

2. The hydraulic control apparatus according to claim 1, wherein the control valve operation control means controls only the first oil flow control valve by interrupting the control of the second oil flow control valve that supplies the oil from the pressurized oil source and passes the oil into the oil discharge passage such that the operation direction of the hydraulic servo unit is selected to the first operation direction.

3. The hydraulic control apparatus according to claim 1 or 2, wherein the control valve operation control means controls only the second oil flow control valve by interrupting the control of the first oil flow control valve that supplies the oil from the pressurized oil source and passes the oil into the oil discharge passage such that the operation direction of the hydraulic servo unit is selected to the second operation direction.

4. The hydraulic control apparatus according to any one of claims 1 to 4, further comprising oil passage selection means that selectively changes an inlet between the first port and the second port.
5. The hydraulic control apparatus according to any one of claims 1 to 4, further comprising depressurize oil supply means that supplies a pressurized oil from the pressurized oil source, which has been depressurized to at least one of the first and the second ports by bypassing the first and the second oil flow control valves.
6. The hydraulic control apparatus according to claim 5, wherein the hydraulic servo unit comprises a transmission for a vehicle, and the pressurized oil is supplied to a port to which the pressurized oil is supplied for an upshifting operation of the transmission by the depressurize oil supply unit.
7. The hydraulic control apparatus according to claim 5 or 6, wherein the depressurize oil supply means is activated when one of the first and the second oil flow control valves fails to supply the pressurized oil.
8. The hydraulic control apparatus according to any one of claims 5 to 7, wherein an oil pressure of the pressurize oil source is temporarily increased when the depressurize oil supply means is operated.
9. The hydraulic control apparatus according to any one of claims 5 to 8, wherein a control for reducing a torque input to the hydraulic servo unit is executed when the depressurize oil supply unit is operated.
10. The hydraulic control apparatus according to any one of claims 5 to 8, wherein the hydraulic servo unit comprises a toroidal type continuously variable transmission, and an engine output of the vehicle is reduced when the depressurize oil supply means is operated.
11. The hydraulic control apparatus according to any one of claims 1 to 9, wherein the hydraulic servo unit comprises a toroidal type continuously variable transmission.

12. The hydraulic control apparatus according to claim 11, wherein:

the toroidal type continuously variable transmission includes a roller supported by a support member and interposed between a pair of rotating members, and an actuator having a piston connected to the support member and an upper hydraulic chamber formed above the piston and a lower hydraulic chamber formed below the piston; and

the roller is deflected with respect to the rotating members while the actuator is displacing the support member in a vertical direction.

13. The hydraulic control apparatus according to claim 12, wherein the control valve operation control means serves to activate the second oil flow control valve when the toroidal type continuously variable transmission is operated in the first operation direction, and the first oil flow control valve fails to stop supplying the oil to the lower hydraulic chamber after a flow rate of the supplied oil exceeds a predetermined target value.

14. The hydraulic control apparatus according to claim 12 or 13, wherein the control valve operation control means serves to activate the first oil flow control valve when the toroidal type continuously variable transmission is operated in the second operation direction, and the second oil flow control valve fails to stop supplying the oil to the upper hydraulic chamber after a flow rate of the supplied oil exceeds a predetermined target value.

15. A method of controlling a hydraulic control apparatus for a hydraulic servo unit that selectively changes an operation direction between a first direction when an oil is supplied from a first port and discharged from a second port and a second direction opposite to the first direction when the oil is supplied from the second port and discharged from the first port, the hydraulic control apparatus including a first oil flow control valve and a second oil flow control valve each having an oil supply control portion that controls an oil supply from a pressurized oil source, and an oil discharge control portion that controls a connection to an oil discharge passage, the method comprising the steps of:

controlling an oil supply from the oil supply control portion of the first oil flow control valve and an oil discharge through the oil discharge control portion of the second oil flow control valve; and

controlling an oil supply from the oil supply control portion of the second oil flow control valve and an oil discharge through the oil discharge control portion of the first oil

flow control valve.

16. The method according to claim 21, wherein the first oil flow control valve is only controlled by interrupting the control of the second oil flow control valve that supplies the oil from the pressurized oil source and passes the oil into the oil discharge passage such that the operation direction of the hydraulic servo unit is selected to the first operation direction.

17. The method according to claim 21, wherein the second oil flow control valve is only controlled by interrupting the control of the first oil flow control valve that supplies the oil from the pressurized oil source and passes the oil into the oil discharge passage such that the operation direction of the hydraulic servo unit is selected to the second operation direction.

18. The method according to claim 21, further comprising selectively changing an inlet between the first port and the second port.

19. The method according to claim 21, wherein a pressurized oil from the pressurized oil source, which has been depressurized is supplied to at least one of the first and the second port by bypassing the first and the second oil flow control valves.

20. The method apparatus according to claim 19, wherein the pressurized oil from the pressurized oil source, which has been depressurized is supplied to at least one of the first and the second port by bypassing the first and the second oil flow control valves when one of the first and the second oil flow control valves fails to supply the pressurized oil.

21. The method according to claim 19 or 20, wherein an oil pressure of the pressurize oil source is temporarily increased when the pressurized oil from the pressurized oil source, which has been depressurized is supplied.

22. The method according to any one of claims 19 to 21, wherein a control for reducing a torque input to the hydraulic servo unit is executed when the pressurized oil from the pressurized oil source, which has been depressurized is supplied.

23. The method according to any one of claims 19 to 22, wherein the hydraulic servo unit comprises a toroidal type continuously variable transmission, and an engine output of the vehicle is reduced when the pressurized oil from the pressurized oil source, which has been depressurized is supplied.

AMENDED CLAIMS

[received by the International Bureau on 22 December 2004 (22.12.2004);
original claims 1-23 replaced by new claims 1-22 (7 pages)]

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New Claims 1 - 22

10 1. A hydraulic control apparatus for a hydraulic servo
unit that selectively changes an operation direction
between a first direction when an oil is supplied from a
first port and discharged from a second port and a second
direction opposite to the first direction when the oil is
15 supplied from the second port and discharged from the first
port, the hydraulic control apparatus characterized by
comprising:

a first oil flow control valve and a second oil flow
control valve each having an oil supply control portion
20 that controls an oil supply from a pressurized oil source,
and an oil discharge control portion that controls a
connection with an oil discharge passage; and

control valve operation control means that controls
each operation of the first and the second oil flow control
25 valves,

wherein the first port receives an oil supply from the
oil supply control portion of the first oil flow control
valve, and discharges the oil through the oil discharge
control portion of the second oil flow control valve,

30 wherein the second port receives the oil supply from
the oil supply control portion of the second oil flow
control valve, and discharges the oil through the oil
discharge control portion of the first oil flow control
valve,

35 wherein an operation state of the hydraulic servo unit
is controlled by the control valve operation control means

that controls each operation of the first and the second oil flow control valves,

wherein the hydraulic servo unit comprises a toroidal type continuously variable transmission.

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2. The hydraulic control apparatus according to claim 1, wherein the control valve operation control means controls only the first oil flow control valve by interrupting the control of the second oil flow control valve that supplies the oil from the pressurized oil source and passes the oil into the oil discharge passage such that the operation direction of the hydraulic servo unit is selected to the first operation direction.

15 3. The hydraulic control apparatus according to claim 1 or 2, wherein the control valve operation control means controls only the second oil flow control valve by interrupting the control of the first oil flow control valve that supplies the oil from the pressurized oil source and passes the oil into the oil discharge passage such that the operation direction of the hydraulic servo unit is selected to the second operation direction.

25 4. The hydraulic control apparatus according to any one of claims 1 to 3, further comprising oil passage selection means that selectively changes an inlet between the first port and the second port.

30 5. The hydraulic control apparatus according to any one of claims 1 to 4, further comprising depressurize oil supply means that supplies a pressurized oil from the pressurized oil source, which has been depressurized to at least one of the first and the second ports by bypassing

the first and the second oil flow control valves.

6. The hydraulic control apparatus according to claim 5, wherein the hydraulic servo unit comprises a transmission for a vehicle, and the pressurized oil is supplied to a port to which the pressurized oil is supplied for an upshifting operation of the transmission by the depressurize oil supply unit.

7. The hydraulic control apparatus according to claim 5 or 6, wherein the depressurize oil supply means is activated when one of the first and the second oil flow control valves fails to supply the pressurized oil.

8. The hydraulic control apparatus according to any one of claims 5 to 7, wherein an oil pressure of the pressurize oil source is temporarily increased when the depressurize oil supply means is operated.

9. The hydraulic control apparatus according to any one of claims 5 to 8, wherein a control for reducing a torque input to the hydraulic servo unit is executed when the depressurize oil supply unit is operated.

10. The hydraulic control apparatus according to any one of claims 5 to 8, wherein the hydraulic servo unit comprises a toroidal type continuously variable transmission, and an engine output of the vehicle is reduced when the depressurize oil supply means is operated.

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11. The hydraulic control apparatus according to claim 1, wherein:
the toroidal type continuously variable transmission

includes a roller supported by a support member and interposed between a pair of rotating members, and an actuator having a piston connected to the support member and an upper hydraulic chamber formed above the piston and
5 a lower hydraulic chamber formed below the piston; and
the roller is deflected with respect to the rotating members while the actuator is displacing the support member in a vertical direction.

10 12. The hydraulic control apparatus according to claim 11, wherein the control valve operation control means serves to activate the second oil flow control valve when the toroidal type continuously variable transmission is operated in the first operation direction, and the first
15 oil flow control valve fails to stop supplying the oil to the lower hydraulic chamber after a flow rate of the supplied oil exceeds a predetermined target value.

13. The hydraulic control apparatus according to
20 claim 11 or 12, wherein the control valve operation control means serves to activate the first oil flow control valve when the toroidal type continuously variable transmission is operated in the second operation direction, and the second oil flow control valve fails to stop supplying the
25 oil to the upper hydraulic chamber after a flow rate of the supplied oil exceeds a predetermined target value.

14. A method of controlling a hydraulic control
apparatus for a hydraulic servo unit that selectively
30 changes an operation direction between a first direction when an oil is supplied from a first port and discharged from a second port and a second direction opposite to the first direction when the oil is supplied from the second

port and discharged from the first port, the hydraulic control apparatus including a first oil flow control valve and a second oil flow control valve each having an oil supply control portion that controls an oil supply from a pressurized oil source, and an oil discharge control portion that controls a connection to an oil discharge passage, the method comprising the steps of:

controlling an oil supply from the oil supply control portion of the first oil flow control valve and an oil discharge through the oil discharge control portion of the second oil flow control valve; and

controlling an oil supply from the oil supply control portion of the second oil flow control valve and an oil discharge through the oil discharge control portion of the first oil flow control valve,

wherein the hydraulic servo unit comprises a toroidal type continuously variable transmission.

15. The method according to claim 14, wherein the first oil flow control valve is only controlled by interrupting the control of the second oil flow control valve that supplies the oil from the pressurized oil source and passes the oil into the oil discharge passage such that the operation direction of the hydraulic servo unit is selected to the first operation direction.

16. The method according to claim 14 or 15, wherein the second oil flow control valve is only controlled by interrupting the control of the first oil flow control valve that supplies the oil from the pressurized oil source and passes the oil into the oil discharge passage such that the operation direction of the hydraulic servo unit is selected to the second operation direction.

17. The method according to any one of claims 14 to 16, further comprising selectively changing an inlet between the first port and the second port.

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18. The method according to any one of claims 14 to 17, wherein a pressurized oil from the pressurized oil source, which has been depressurized is supplied to at least one of the first and the second port by bypassing the first and the second oil flow control valves.

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19. The method apparatus according to claim 18, wherein the pressurized oil from the pressurized oil source, which has been depressurized is supplied to at least one of the first and the second port by bypassing the first and the second oil flow control valves when one of the first and the second oil flow control valves fails to supply the pressurized oil.

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20. The method according to claim 18 or 19, wherein an oil pressure of the pressurize oil source is temporarily increased when the pressurized oil from the pressurized oil source, which has been depressurized is supplied.

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21. The method according to any one of claims 18 to 20, wherein a control for reducing a torque input to the hydraulic servo unit is executed when the pressurized oil from the pressurized oil source, which has been depressurized is supplied.

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22. The method according to any one of claims 18 to 21, wherein the hydraulic servo unit comprises a toroidal type continuously variable transmission, and an engine

output of the vehicle is reduced when the pressurized oil from the pressurized oil source, which has been depressurized is supplied.

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